Advanced Space Suit Project (formerly Extravehicular Activity Suit/Portable Life Support System)

Completed Technology Project (2011 - 2016)

Project Introduction

The primary objective of the Advanced Space Suit project is to develop EVA Systems technology to enhance and enable efficient human exploration missions to any destination. The project is focused on technologies for a new advanced Portable Life Support System (PLSS), Power and Avionics Systems, and Pressure Garment Systems (PGS) to support human exploration to asteroids, the Moon, and planetary bodies such as Mars and its moons. The challenges of working in these exploration environments exceed those of the current ISS system and will require that all new technologies be more robust, tolerant of dusty environments, work in both vacuum and non-vacuum environments, and support increased crew autonomy.

Project was transferred to the International Space Station Program in the middle of FY16.

The objective of this project is to mature technologies and systems that will enable future Extravehicular Activity (EVA) systems. Advanced EVA systems have applicability to all future human spaceflight missions. Advanced EVA systems have applications to current operations on the International Space Station (ISS), to extended operations on ISS past 2020, future missions to Low Earth Orbit (LEO) such as satellite servicing, missions beyond LEO such as exploration of asteroids, and surface exploration missions to the Moon or Mars. An EVA system would be a significant element of any future human exploration mission and will enable suitport operations in a Deep Space Habitat or Multi-Mission Space Exploration Vehicle (MMSEV). The Human Exploration Framework Team (HEFT) ranked EVA systems as one of the top five needed areas of future development for human space flight. The project's goal is to produce real cost, performance, and reliability data through building and testing high fidelity systems, culminating in a flight demonstration on ISS of an exploration Extravehicular Mobility Unit (EMU). The current plan leading to this flight demonstration consists of subsystem demonstrations of increasing fidelity. These demonstrations would produce hardware and systems that could then be combined into a complete EVA system which would be used in human thermal-vacuum chamber tests and finally in a flight demonstration.

Anticipated Benefits

Increased EVA time, reduced consumables, decreased crew time for maintenance and checkout, EVA capability in multiple environments and destinations

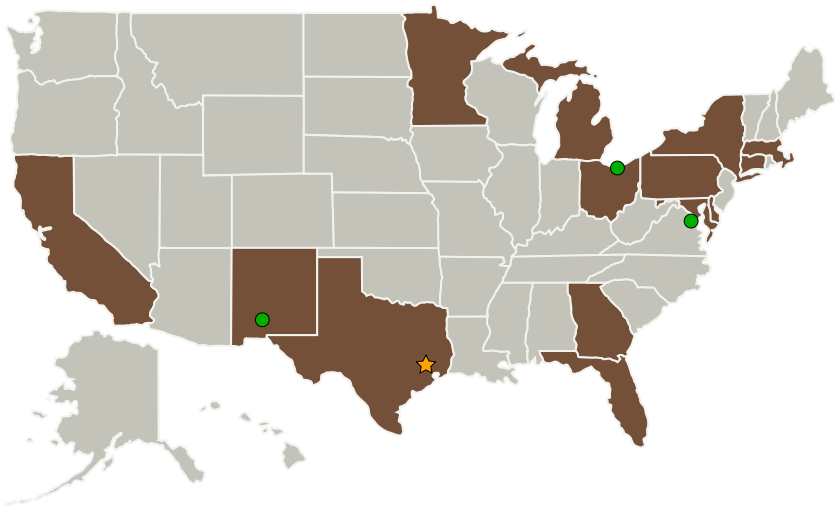
Z-1 suitport interfaces testing with the MMSEV prototype vehicle.

Table of Contents

Advanced Space Suit Project (formerly Extravehicular Activity Suit/Portable Life Support System)

Completed Technology Project (2011 - 2016)

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Exploration Systems Development Mission Directorate (ESDMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Exploration Capabilities

Project Management

Program Director:

Christopher L Moore

Project Managers:

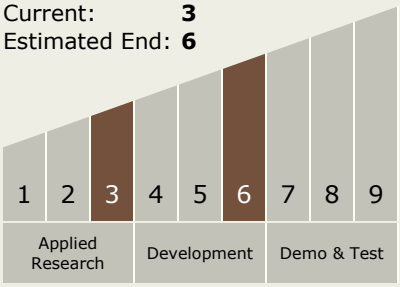
Lindsay T Aitchison
Liana R Rodriggs

Principal Investigator:

Liana R Rodriggs

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **6**



Advanced Space Suit Project (formerly Extravehicular Activity Suit/Portable Life Support System)

Completed Technology Project (2011 - 2016)

Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Air-Lock, Inc.	Supporting Organization	Industry	Milford, Connecticut
Cobham Life Support	Supporting Organization	Industry	
David Clark Company Incorporated	Supporting Organization	Industry	Worcester, Massachusetts
First-Cut	Supporting Organization	Industry	Minnesota
Georgia Institute of Technology-Main Campus(GA Tech)	Supporting Organization	Academia	Atlanta, Georgia
●Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
Hamilton Sundstrand Space Systems International Inc	Supporting Organization	Industry	
Harris Engineering	Supporting Organization	Industry	Richmond, Texas
ILC Dover	Supporting Organization	Industry	Newark, Delaware
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas
●NASA Headquarters(HQ)	Supporting Organization	NASA Center	Washington, District of Columbia

Continued on following page.

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.2 Mission Infrastructure, Sustainability, and Supportability
    - TX07.2.1 Logistics Management

Target Destinations

The Moon, Mars, Earth

Supported Mission Type

Planned Mission (Pull)

Advanced Space Suit Project (formerly Extravehicular Activity Suit/Portable Life Support System)

Completed Technology Project (2011 - 2016)

Organizations Performing Work	Role	Type	Location
Oceaneering International Inc.	Supporting Organization	Industry	Houston, Texas
Philadelphia University	Supporting Organization	Academia	Pennsylvania
Physical Optics Corporation	Supporting Organization	Industry	Torrance, California
Pratt & Miller Engineering	Supporting Organization	Industry	Michigan
Turn-Key Coatings	Supporting Organization	Industry	Texas
University of Delaware Center for Composite Materials	Supporting Organization	Academia	Newark, Delaware
University of Minnesota-Twin Cities	Supporting Organization	Academia	Minneapolis, Minnesota
UTC Aerospace Systems(UTAS)	Supporting Organization	Industry	Connecticut
Vista Photonics, Inc.	Supporting Organization	Industry	Santa Fe, New Mexico
White Sands Test Facility(WSTF)	Supporting Organization	NASA Facility	Las Cruces, New Mexico
Wolverine	Supporting Organization	Industry	Michigan
Wyle Laboratories, Inc.	Supporting Organization	Industry	
Xigen, LLC	Supporting Organization	Industry	Rockville, Maryland

Advanced Space Suit Project (formerly Extravehicular Activity Suit/Portable Life Support System)

Completed Technology Project (2011 - 2016)

Primary U.S. Work Locations	
California	Connecticut
Delaware	District of Columbia
Florida	Georgia
Maryland	Massachusetts
Michigan	Minnesota
New Mexico	New York
Ohio	Pennsylvania
Texas	

Project Transitions

October 2011: Project Start

September 2016: Closed out

Closeout Summary: Project was transferred to the International Space Station Program in the middle of FY16. The Advanced Space Suit Project successfully matured technologies and system designs for an exploration space suit. Component-level technologies for life support, avionics, and pressure garments were designed, prototyped, and tested to advance the technology readiness level prior to integrating them into functional systems. The pressure garment technology development culminated in the design and manufacture of the Z-2 prototype suit. The Z-2 is the highest fidelity planetary prototype suit since Apollo. It was tested in the Neutral Buoyancy Laboratory to demonstrate the ability of a highly mobile, rear-entry suit to perform microgravity EVA and in laboratory settings to demonstrate the advances in mobility that will be required to successfully perform EVA's on planetary surfaces. The portable life support system and power, avionics, and software technology development culminated in the design and manufacture of the PLSS 2.0 prototype which was extensively tested in laboratory and vacuum conditions. The PLSS 2.0 was also tested in a Human-in-the-Loop evaluation to assess its performance with a real human metabolic load. In addition to the advances in EVA hardware, there was extensive development of system requirements and hardware specifications which together with the hardware advances, establish the basis for all future NASA EVA development.

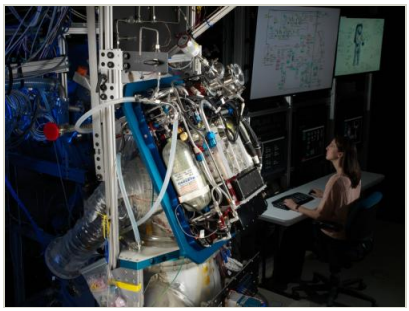
Images

Human-in-the-loop testing of the PLSS 2.0 system with the MK-III space suit prototype-1

Human-in-the-loop testing of the PLSS 2.0 system with the MK-III space suit prototype-1 *(https://techport.nasa.gov/image/36944)*

Human-in-the-loop testing of the PLSS 2.0 system with the MK-III space suit prototype-2

Human-in-the-loop testing of the PLSS 2.0 system with the MK-III space suit prototype-2 *(https://techport.nasa.gov/image/36945)*



Project Engineer conducting system checkouts of the Suited Manikin Test Apparatus.

Project Engineer conducting system checkouts of the Suited Manikin Test Apparatus. *(https://techport.nasa.gov/image/36940)*

Suit Engineering demonstrating the impressive mobility of the Z-1 prototype.

Suit Engineering demonstrating the impressive mobility of the Z-1 prototype. *(https://techport.nasa.gov/image/36942)*

Z-1 suitport interfaces testing with the MMSEV prototype vehicle.

Z-1 suitport interfaces testing with the MMSEV prototype vehicle. *(https://techport.nasa.gov/image/36941)*

Z-2 Advanced Prototype Pressure Garment in Donning Stand
Z-2 Advanced Prototype Pressure Garment in Donning Stand
(https://techport.nasa.gov/image/36948)

Z1 suit in its donning stand.
Z1 suit in its donning stand.
(https://techport.nasa.gov/image/36943)

Stories

Success Story AES Advanced Space Suit PLSS 2015-08-28
(https://techport.nasa.gov/file/51796)

Project Website:

http://www.nasa.gov/exploration/technology/advanced_space_suits/index.html#.UzwNd_ldWAg